On the Orbit and Relative Masses of β 733 (85 Pegasi).

By W. Bowyer and H. H. Furner.

β 733.

R.A.	$23^h\ 56^m\ 57^s$	1900	Mags. 6 : 10
N.P.D.	$63°\ 27'$		

The discussion of the meridian observations of 85 *Pegasi* for a determination of the relative masses, incidentally showed that the period of this binary did not exceed twenty-five years.

The orbit has been computed at various times, the results so far as the period is concerned being—

	Years.
1888 Schaeberle...	22·3
1892 Glasenapp	17·5
1895 See...	24·0
1899 Burnham	25·7

This failure to secure harmony has led to a discussion of the micrometer measures, which are best satisfied by a period of twenty-six years—*i.e.* a little larger than that deduced by Professor Burnham.

The meridian observations extend over a period of seventy-five years, or three revolutions, and the period given can be assumed to be more accurate than that at present derived from the micrometer measures. One explanation of the discrepancy may be found in the difficulty of measuring so close and dissimilar a pair; but there is a tendency to periods of alternate positive and negative residuals when comparing observed and computed places which would point to some real disturbing cause. This would show to a greater extent in the micrometer measures than in the meridian observations.

In Fig. 1 all available measures have been taken in groups, plotted down, and the apparent ellipse drawn. From this the elements of the true ellipse have been found to be:—

$e = \cdot 46$	$a = 0''\cdot 82$
$\Omega = 115^\circ\ 38'$	$T = 1883\cdot 5$
$\gamma = 53\ \ 5$	$P = 26\cdot 3$ years
$\lambda = 266\ \ 7$	

From the apparent ellipse the relative movement of the two components is found to be $1''\cdot 35$ in right ascension and $1''\cdot 05$ in

north polar distance, these being the values used in the following discussion of the masses.

Several more years' micrometer measures would appear desirable before a really satisfactory investigation of the system can be made. Of late, observations of the pair are somewhat scarce, but double-star observers would do well to keep this binary under careful measurement for some time to come.

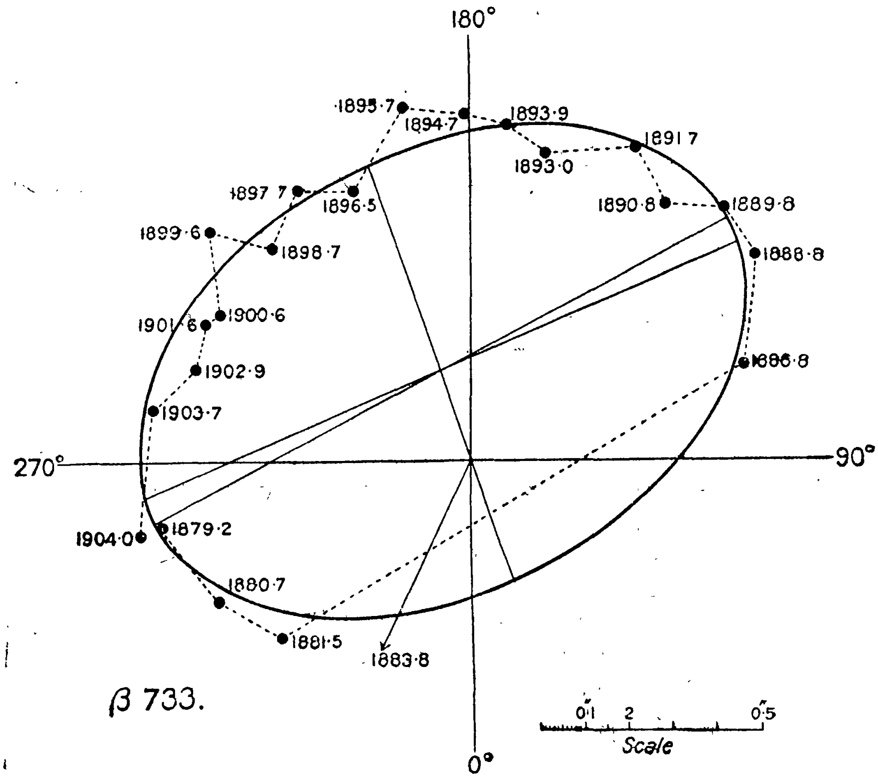

Fig. 1.—Apparent Ellipse.

On the Mass of 85 *Pegasi.*

The system 85 *Pegasi* consists of a sixth-magnitude star whose colour is yellow, and a tenth-magnitude star whose colour is blue. It is a close pair, but the great difference in brightness allows us to assume that the meridian observations are of the bright component, or that the effect of the faint companion on the bisections may be neglected. The following observations have been corrected by Auwers' corrections and for proper motion.

The observations extend over a period of seventy-five years, and so actually date two complete revolutions anterior to the discovery of the faint companion by Burnham in 1878. A very good determination of the period is therefore possible. It may be taken as 24·5 years. The meridian observations give a range

of 1″·15 in R.A., and 0″·8 in N.P.D. (see fig. 2), corresponding to a range of 1″·35 and 1″·05 in the relative orbit, and hence

$$\frac{\text{Mass A}}{\text{Mass B}} = \frac{1{\cdot}35 - 1{\cdot}15}{1{\cdot}15} = \frac{4}{23} \text{ from R.A.}$$

and

$$= \frac{1{\cdot}05 - 0{\cdot}8}{{\cdot}8} = \frac{5}{16} \text{ from N.P.D.}$$

giving equal weight to each, the mass of the faint star is approximately four times that of the bright star.

Right Ascensions and North Polar Distances of 85 *Pegasi reduced to the Epoch* 1900·0 *with Auwers' Systematic Corrections applied. Adopted Proper Motions.*

+0s·0612 *in R.A. and* +0″·980 *in N.P.D.*

Cat.	Epoch of Obs. R.A.	No. of Obs.	Secs. R.A. 1900·0.	Epoch of Obs. N.P.D.	No. of Obs.	Secs. N.P.D. 1900·0.
			s			″
Argelander ...	1830	11	56·77	1830	11	50·3
Armagh ...	1831·6	6	56·70	1846·2	7	48·1
Taylor ...	1835·4	10	56·72	1836·5	10	50·2
Rumker ...	1845·0	3	56·67	1845·0	3	48·4
Paris	1849·8	2	56·82	...	...	...
Radcliffe ...	1857·3	4	56·76	1860·1	3	51·8 }
Brussels ...	1860·8	25	56·71	1857·5	18	50·4 }
Paris	1864·1	21	56·74	1861·8	2	49·6
Greenwich ...	1866·2	3	56·64	1866·2	3	49·8
Paris	1871·9	2	(56·82)	1871·8	1	49·5
Greenwich ...	1873·6	5	56·67	1873·9	7	49·8 }
Camb. (Eng.)...	1874·0	4	56·71	1874·0	4	49·6 }
Romberg ...	1875·3	5	56·74	1875·3	5	49·6 }
Greenwich ...	1882·1	3	56·72	1881·3	4	50·5
Washington ...	1885·2	15	56·70	1885·2	15	49·5
Dunsink ...	1886·2	4	56·67	1886·2	4	50·3
Cincinnati ...	1889·8	4	56·64	1889·8	4	50·0
Glasgow ...	1891·9	2	56·78 }	1891·9	2	49·8
Greenwich ...	1894·7	17	56·72 }	1894·4	20	49·8
Greenwich ...	1897·0	1	(57·00)	1897·0	1	50·0 }
Cincinnati ...	1899·8	3	56·72	1899·8	3	49·2 }
Greenwich ...	1905·8	4	56·77	1905·7	4	50·0

The relative masses may be derived in a different manner. Besides the two stars A and B which make up the binary, there is a third star, C, of the ninth magnitude, whose position with respect to A has been repeatedly measured. Its apparent motion

with respect to A for the last fifty years is exactly equal and opposite to the proper motion of A, and may therefore be considered as fixed in the sky. If, however, the star A has an orbital motion, the apparent motion of C, instead of being equal and rectilinear from year to year, should be affected by this change of position of A. The measures may be treated in two ways; but in each method it is first requisite to change the polar coordinates θ and ρ into differences of right ascension and declination. This being done we may correct for proper motion of A and solve the equations

$$\rho' . \cos\theta' = c\rho . \cos\theta + \Delta\delta$$
$$\rho' . \sin\theta' = c\rho . \sin\theta + \Delta\alpha$$

where ρ and ρ' are distances of B and C from A
θ ,, θ' ,, position-angles ,, ,, ,,
$\Delta\alpha$,, $\Delta\delta$,, differences ,, R.A. and Decl. of C and the centre of gravity of A and B

and $c\rho$ is the distance of A from the centre of gravity.

	Position-angle.	Distance.	Diff. R.A. reduced to 1900.	Diff. N.P.D. reduced to 1900.
	°	″	″	″
1851·96	114·1	33·03	9·77	33·58
52·67	113·9	32·60	9·49	33·13
65·91	92·1	18·89	9·43	32·72
68·77	82·4	17·03	9·04	32·83
69·98	77·8	16·13	9·23	32·86
70·65	74·4	15·47	9·45	32·89
74·66	54·4	13·92	9·71	32·91
76·77	40·3	14·02	10·22	33·43
77·94	39·8	14·00	9·36	32·36
78·54	33·6	14·40	9·87	33·03
78·74	32·8	14·76	9·64	33·24
79·27	30·4	14·96	9·65	33·23
80·57	25·0	15·41	9·64	33·01
81·61	20·6	16·34	9·51	33·32
82·73	16·7	17·25	9·38	33·45
83·54	11·3	17·34	[10·25]	33·16
86·24	7·6	19·84	8·74	33·17
86·99	6·1	21·15	8·78	33·78
88·67	0·9	21·71	9·05	32·77 }
89·61	358·6	22·69	9·28	32·86 }
90·52	356·7	23·59	9·45	32·83

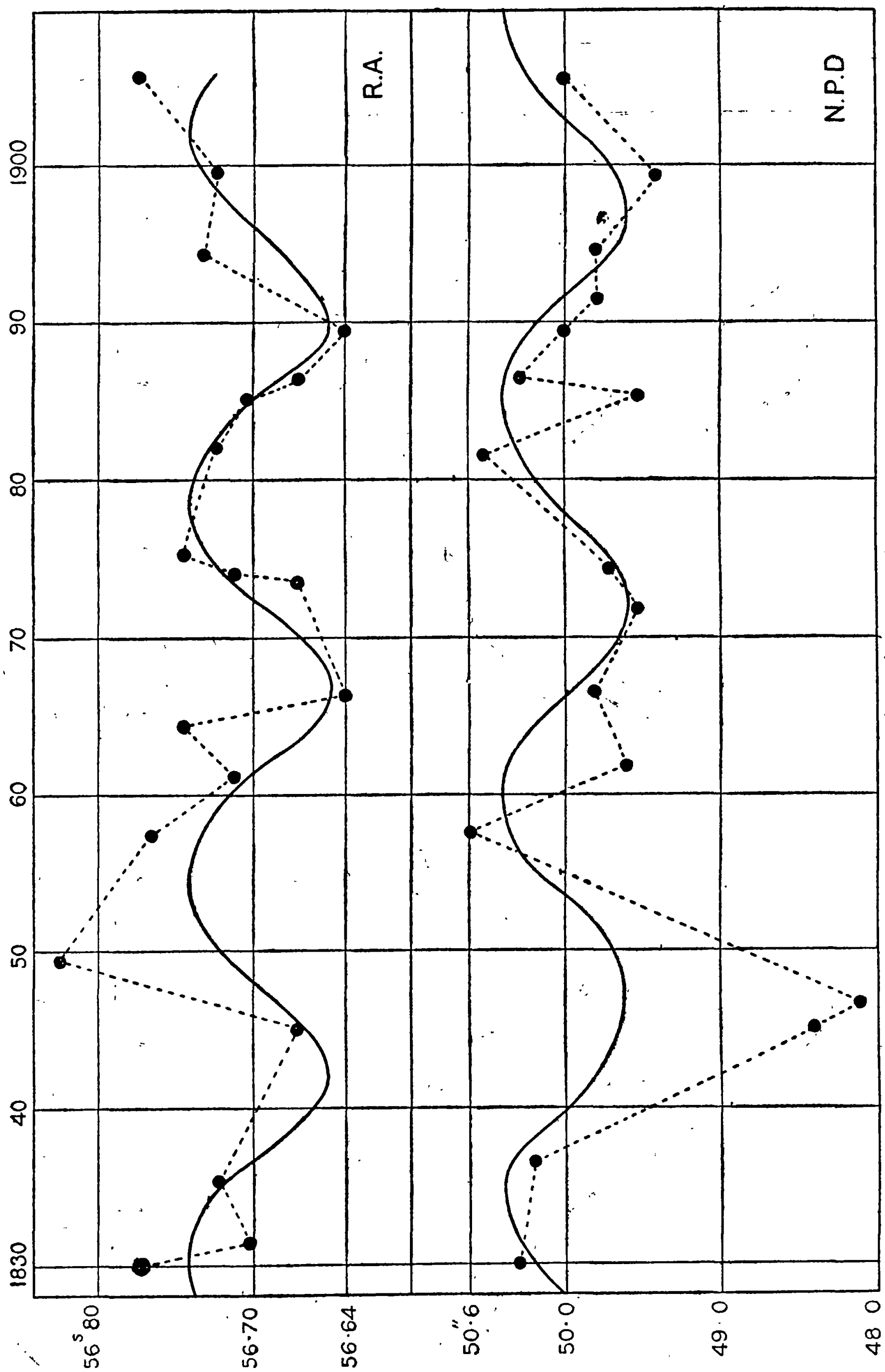

FIG. 2.—Diagram showing R.A.s and N.P.D.s of 85 *Pegasi* from T.C. Observations.

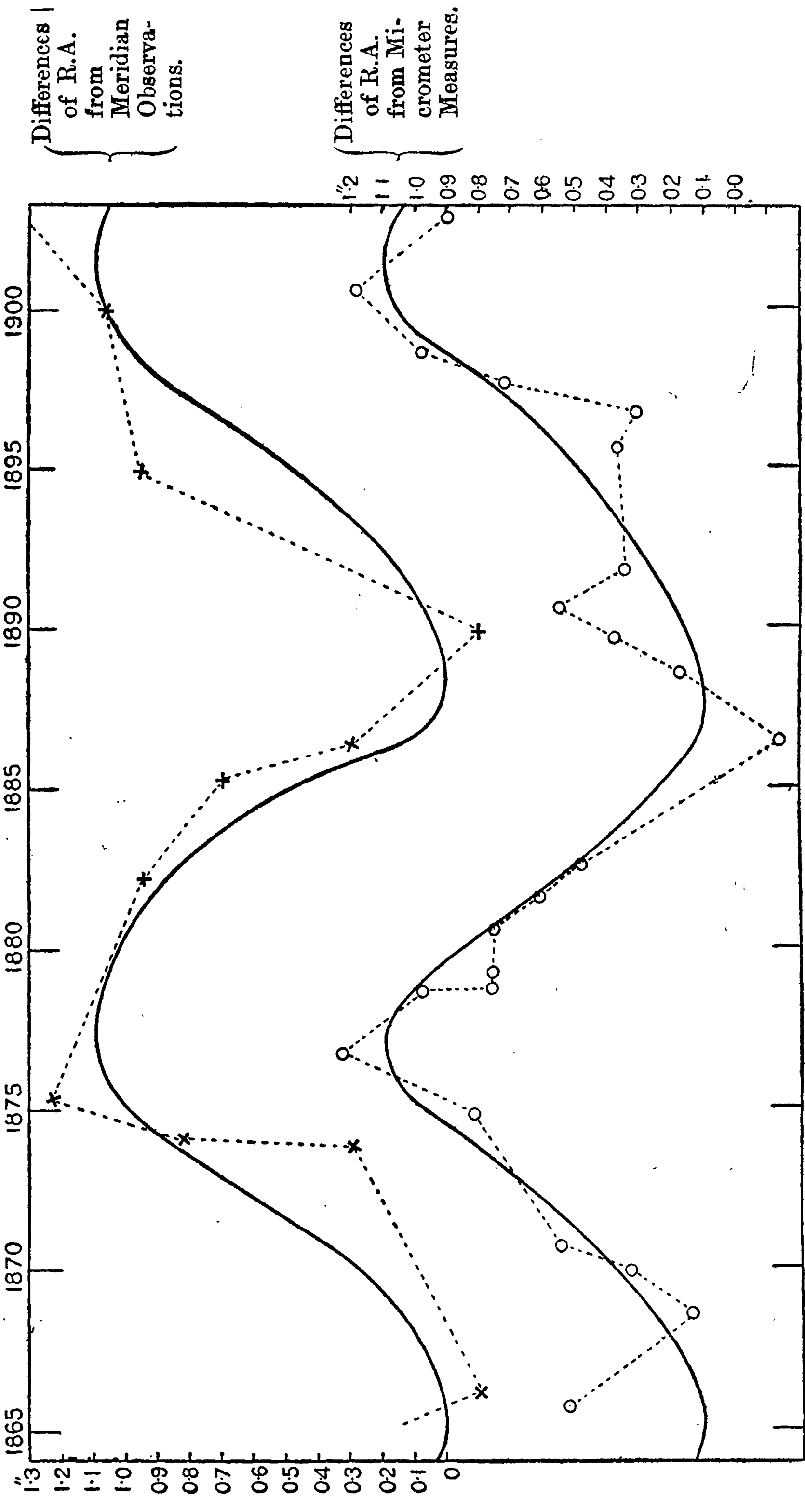

Fig. 3.—Comparison of Meridian and Micrometer Places of 85 *Pegasi*.

	Position-angle.	Distance.	Diff. R.A. reduced to 1900.	Diff. N.P.D. reduced to 1900.
	°	″	″	″
1891·84	354·4	24·90	9·25	32·78
95·53	349·0	29·17	9·27	33·01
96·75	347·8	30·48	9·20	32·98
97·69	345·9	31·62	9·62	32·93
98·57	344·4	32·68	9·86	32·92
1900·66	342·9	35·15	9·74	32·97 }
00·86	342·3	36·60	10·41	34·03 }
02·73	341·3	37·64	9·79	32·98

The graphical method has, however, the advantage of exhibiting more clearly the movement of the principal star. The corrected differences of right ascension and declination are disposed in two curves, and the amplitude of the curves compared with the similar extent of change in the apparent orbit. These two curves are not given, but the third diagram shows the R.A. curve and the corresponding portion of the first curve in fig. 2 to show the close agreement.

Thus if $1''\cdot35$ be the extent in R.A. of the relative orbit and $1''\cdot00$ be the extent in R.A. of the difference in R.A., we have

$$\frac{1\cdot35-1\cdot00}{100}=\frac{7}{20}=\frac{\text{Mass A}}{\text{Mass B}}$$

from the right ascension differences, and similarly

$$\frac{1\cdot05-0\cdot75}{\cdot75}=\frac{2}{5}=\frac{\text{Mass A}}{\text{Mass B}}$$

from the N.P.D., giving equal weight to each; then

$$\frac{\text{Mass A}}{\text{Mass B}}=\frac{3}{8}$$

Incidentally it gives the period of 85 *Pegasi* as 24·0 years, a result deserving of equal confidence with that derived from direct measures of A and B.

The star C was employed by Brünnow to determine the parallax of 85 *Pegasi*, which he found to be $0''\cdot054$.

The parallax according to Flint is $0''\cdot03$. Spectrum, D.C. 1890—E (Type II.).

New Double Stars. By the Rev. T. E. Espin, M.A.

The Spring has been unusually good for observing; not only have there been a great number of fine nights, but the definition has been, on the whole, excellent. The stars are entirely situated between 30° and 40° N. declination.

No.	B.D.	R.A. 1900. h m	Decl. ° ′	P. °	D. ″	Mags.		Date.	Nights.	
270	35, 436	2 10·4	+36 0	358·8	2·95	9·2	12·0	06·98	2	BC
				343·7	42·35	...		06·98	2	AB
271	34, 459	26·7	34 48	66·4	1·26	9·5	10·0	06·79	1	
272	35, 551	40·2	35 54	77·0	3·55	9·1	10·5	06·83	2	
273	34, 633	3 16·7	35 0	356·4	2·81	9·1	9·1	06·09	2	
274	...	22·1	35 37	142·4	3·18	9·3	9·4	06·11	3	
275	36, 737	36·3	36 49	297·9	3·41	9·3	10·2	06·13	3	
276	37, 819	37·3	37 40	282·8	7·81	8·0	13·8	06·14	3	
277	34, 741	43·8	34 31	289·7	7·40	10·0	14·0	06·09	2	BC
				142·5	30·24	A=	7·0	06·09	2	AB
278	39, 937	4 2·4	39 54	168·8	1·98	7·7	9·2	06·14	3	
279	34, 866	15·9	35 1	242·6	3·24	9·2	11·2	06·82	2	
280	39, 1201	5 4·9	39 49	302·8	3·19	9·0	10·5	06·14	1	
281	40, 1254	13·5	40 13	215·4	2·29	9·0	9·6	06·14	2	
282	...	21·7	33 44	114·6	1·99	9·1	10·3	06·09	3	
283	39, 1407	39·9	39 56	S.	2±	9·5	9·8	06·13	1	
284	37, 1345	46·5	37 24	184·4	4·73	9·0	11·0	06·07	1	
285	38, 1375	59·6	38 55	167·4	2·33	9·0	9·3	06·15	2	
286	39, 1550	6 6·9	39 45	64·0	2·83	9·0	9·5	06·15	2	
287	37, 1476	12·6	37 21	255·5	6·05	9·0	12·5	06·15	1	
288	39, 1600	14·9	39 11	148·9	4·40	9·0	9·3	06·16	1	AB
				273·8	13·42	C=	12·0	06·16	1	AC
289	39, 1825	55·9	39 6	98·9	1·97	9·4	9·7	06·18	2	
290	36, 1606	7 14·4	36 55	312·4	4·74	9·2	10·0	06·10	3	
291	32, 1667	56·4	32 17	343·4	7·12	8·5	10·2	06·19	2	
292	38, 3876	8 4·9	38 24	165·7	2·50	8·5	9·1	06·18	2	
293	32, 1705	10·5	32 34	214·6	4·76	9·0	9·4	06·22	2	
294	36, 1873	42·8	36 31	162·5	1·70	9·0	9·2	06·11	2	
295	35, 1874	42·8	35 21	306·8	3·58	9·1	11·5	06·74	3	
296	36, 1932	9 6·2	36 47	123·3	1·83	11·5	12·5	06·13	2	BC
				174·2	19·88	A=	8·2	06·13	2	AB
297	39, 2241	18·9	39 11	40·1	3·60	8·6	10·7	06·15	2	
298	39, 2242	19·4	+39 2	308·7	7·89	8·8	11·2	06·17	2	AB